Per Ahlberg

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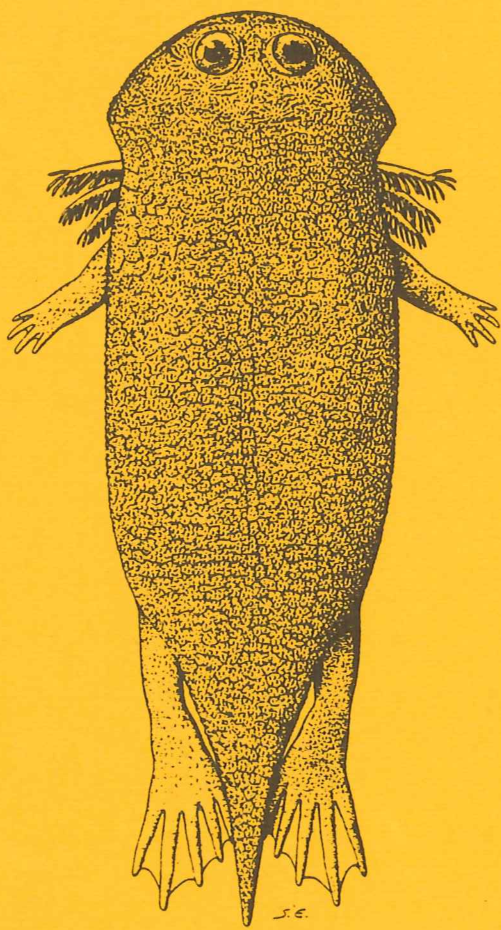

UPPER TRIASSIC DEPOSITIONAL ENVIRONMENTS AT LUNNOM, NORTHWEST SCANIA

ERIK SVENSSON

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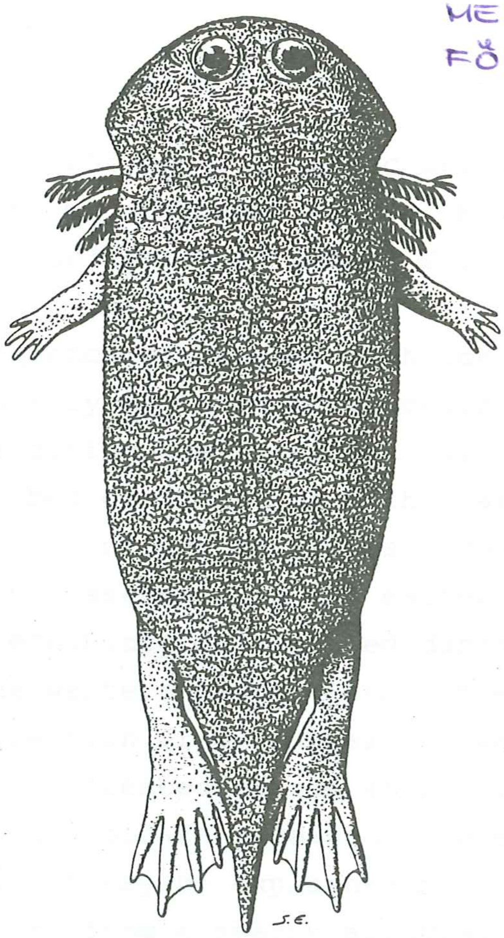

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The mid-Rhaetic sequence at Lunnom, with coal and kaolinitic clays, indicates partly deltaic environments affected by alluvial processes during humid conditions. Of special interest is a thin bed of sandstone with coarse, angular quartz grains. The bed occurs mainly as a covering sheet on top of a heterolithic sequence in the eastern parts of the pit, while it is recognized as isolated dunes inside the heterolithes in the western parts. Lithic trends suggest a palaeotransport direction from southeast towards northwest from continentally influenced source areas. The observed occurence of the bed indicate repeated high energy events. The evental deposition may be explained by crevassing, or due to sediment transport from a nearby alluvial fan, into areas with differentiated subsidence. □*Scania, Lunnom, Upper Triassic, mid-Rhaetic,* Limbosporites-Rhaetipollis *miospore Zone, high energy events, crevasse, non-marine, alluvial plain*. 621490, 132265

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Upper Triassic to Lower Jurassic sequences in NW Scania reflect a large-scale transgression, divided into minor cycles, gradually becoming marine influenced (Troedsson 1951). This transgression coincides with a period when a climatical change took place affecting the Lower Mesozoic sediments (Norling & Bergström 1987). Continental redbeds, settled in a series of alluvial fans on the southern side of the Söderåsen Horst (Sivhed 1986), are succeeded by non-marine to deltaic dark-coloured arenaceous and argillaceous layers with coal-seams indicating more humid conditions (Norling 1982). The deltaic sediments are followed by areanceous deposits affected by marine conditions (Norling 1984).

The climatical change from arid to humid conditions coincides with a deformation phase ranging from Late Triassic to Jurassic times (Norling & Bergström 1987). This phase is known as the Early Kimmerian phase (Stille 1924), and is of major importance for the structural history of Scania (Norling 1984). The phase caused in Scania sinistral wrench faulting and tension along the Tornquist Zone (Norling & Bergström 1987). During Rhaetian times the pulse was rather weak (Norling 1984), and initiated a reactivation of a westward downwarping towards the Danish-Polish Trough (Norling 1982; Bergström *et al.* 1987). Minor tectonical movements and deformations in the colliery districts have been discussed in a series of papers by Bölau (1949, 1951, 1969a, 1969b, 1973), who considered the deformations to be of epeiorogenetic origin.

The Rhaeto-Jurassic sediments in NW Scania were deposited in three subsidence influenced sub-basins. The basins are the results of reactivated tectonical activities causing syn-depositional tensional movements, and are named from north to south, the Ängelholm-, the Höganäs- and the Vallåkra troughs (Fig. 1).

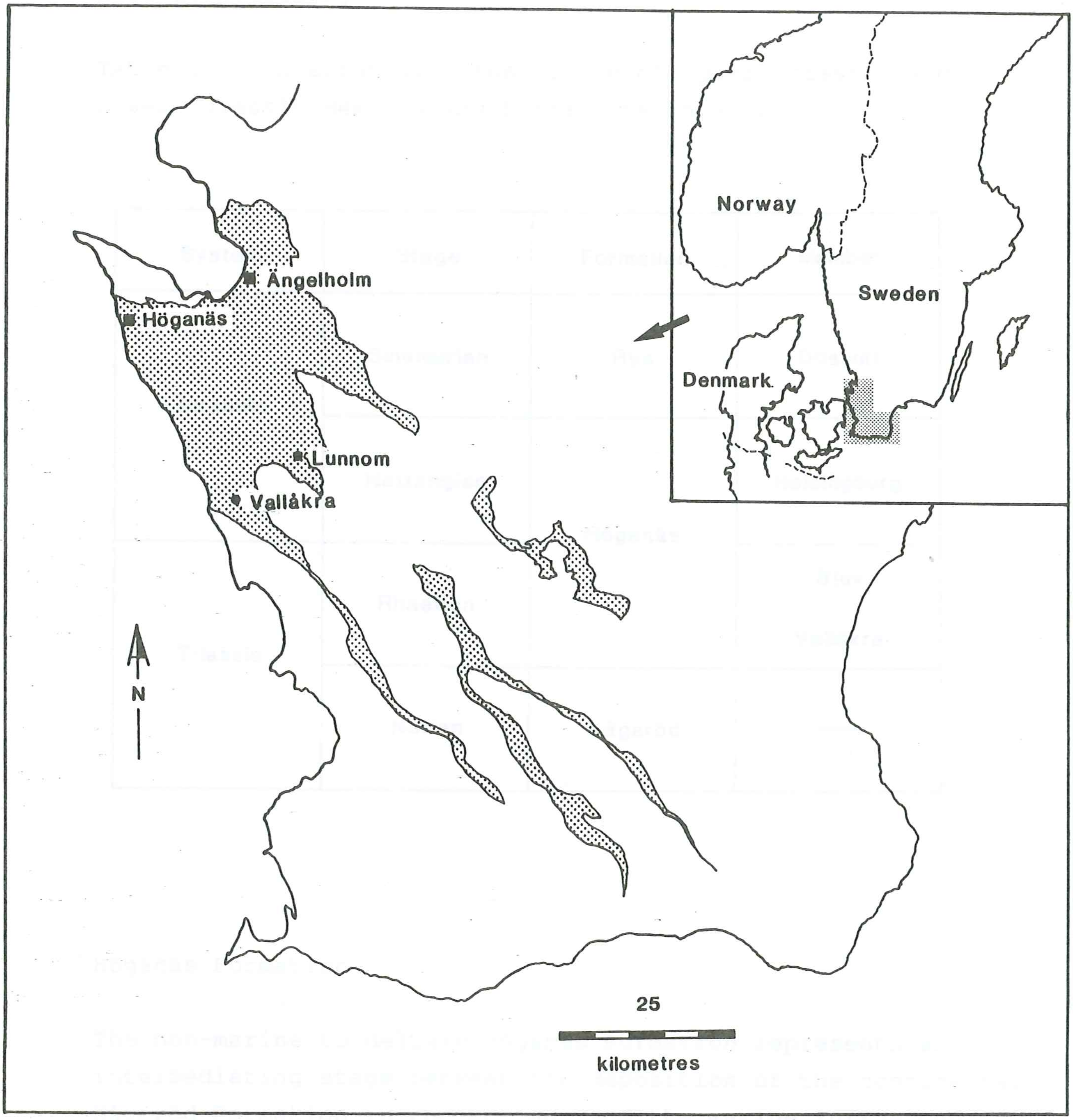

Fig. 1. Distribution of Rhaeto-Jurassic strata in NW Scania covered by Quaternary deposits (after Bergström *et al.* 1982).

Lithostratigraphy

Table 1. Lithostratigraphical table of Upper Triassic and Lower Jurassic Members and Formations in Scania.

System	Stage	Formation	Member
Jurassic	Sinemurian	Rya	Döshult
	Hettangian	Höganäs	Helsingborg
Triassic	Rhaetian		Bjuv
			Vallåkra
	Norian	Kågeröd	—

Höganäs Formation

The non-marine to deltaic Höganäs Formation represents an intermediating stage between the deposition of the continental Kågeröd Formation in the Norian, and the marine influenced Döshult Member in the Sinemurian (Table 1). The Formation comprices the two Rhaetic Vallåkra and Bjuv Members, and the Hettangian Helsingborg Member (Sivhed 1984).

Vallåkra Member.- The Vallåkra Member was first defined and named by Troedsson (1935). It is considered as a transitional unit between the predominately continental Kågeröd Formation (Sivhed 1984), and the well stratified coalbearing strata of the Bjuv Member (Troedsson 1951).

The Member is characteristically poorly stratified with an almost total lack of distinctly developed structures (Troedsson 1938). It consists mainly of redeposited Kågeröd material (Troedsson 1950), strongly influenced by variations in the local source areas (Troedsson 1951). Montmorillonitic clays and fine-grained arenaceous sediments in almost every colour except red occurs frequently in the Member (Norling & Skoglund 1977). A characteristic feature is the presence of sphaerosiderite (Troedsson 1935), because of its green colouration sometimes mistaken for sandstone (Sivhed 1986).

Though the stratotype section is situated at Vallåkra, the Member is more distinctly developed with three subunits at Margareteberg, just north of Höganäs (Bölau 1949).

Bjuv Member.- The Bjuv Member was formerly called the Gruv Member (Erdmann 1911-15; Troedsson 1951), but the name was changed to the Bjuv Member by Sivhed (1984). The Member comprises two coal seams and kaolinitic clays of economic importance (Sivhed 1986), that have been mined for more than two centuries (Norling & Skoglund 1977).

The lower surface of coal seam B forms the boundary to the Vallåkra Member (Troedsson 1935), while the upper surface of coal seam A forms the boundary to the Helsingborg Member (Sivhed 1984). In rare cases there occurs a dark clay with Rhaetian floral elements just above the A seam (Troedsson 1950). Both the A, and the B seams are split up in minor seams close to the Söderåsen Horst (Troedsson 1951, Sivhed 1986).

The sequence of strata intermediating the two main seams consists of arenaceous (Hadding 1929),and argillaceous sediments (Sivhed 1984), in the eastern colliery districts displaying a selective zonation perpendicular to the Söderåsen Horst (Troedsson 1951, p. 99). The distance between the two main Rhaetic coal seams increases towards the northwest in the Höganäs trough (Norling & Skoglund 1977).

In beds just above coal seam B most finds of Lower Mesozoic vertebrates in Scania have been made. A couple of stegocephals are found in grey argillaceous sandstone just above coal seam B at Bjuv (Nilsson 1946a), and ganoidfishes in plantbearing argillaceous sandy shale at Bjuv and Hyllinge (Nilsson 1946b).

The Rhaetic coals and clays in the colliery districts have been thoroughly described in an extensive monograph by Erdmann (1911 - 1915).

Biostratigraphy

The first extensive investigations of the Rhaeto-Liassic macrofloras were performed by Nathorst. In one of his papers (1878), dealing with the floras at Höganäs, he found it possible to distinguish between one older and one younger flora in NW Scania.

Another biostratigraphical study in NW Scania was made at the same time by Lundgren (1878), who based his stratigraphy on mollusc faunas. The composition of the Nathorst - Lundgren schedule comprices in all sixteen zones of the Scanian Rhaeto-Liassic transition (Nathorst 1880, Lundgren 1881), though with another position of the Rhaeto-Liassic boundary than nowadays prevailing (Troedsson 1951).

With his work of Rhaeto-Liassic floras at the Scoresby Sound on Greenland, Harris (1937) emphasized that the transition between Rhaetic and Liassic strata has to be placed between the zone with *Lepidopteris ottonis*, and the zone with *Thaumatopteris schenki* and that this transition also has to be valid in Scania. Stratigraphical investigations of the Rhaeto-Liassic transition in NW Scania based on macrofloras (Troedsson 1943), as well as microfloras (Lundblad 1959b) have confirmed the assumption by Harris.

Extensive investigation of the Rhaeto-Liassic transition, based on palynomorphs, is carried out by Lund (1977). In his paper, mostly dealing with cores from Germany and Denmark he also correlates with Scanian samples. Even if his work seems very diligent, there are a couple of questions arising from his presentation of material from Scania. Some parts of the samples investigated by Lund seem to have been taken from older museal collections of most uncertain origin.

According to Lund (1977) only palynomorphs of Mid-Rhaetic age are present in Scanian, and that an Upper Rhaetic flora is absent in Scania. In the Danish core material, Lund has not only distinguished an Upper Rhaetic zone, but also what he terms as topmost Upper Rhaetic (?), which is not even referred to any zone!

Investigations of the Rhaeto-Liassic palynostratigraphy of the core Valhall 1, by Guy-Ohlson (1981) indicates so far only Mid-Rhaetian palynomorph assemblages in Scania.

Depositional environments

The Rhaetic sediments in NW Scania have in earlier papers been described as deltaic with one addition of each author, as with marine bands (Troedsson 1951), limnic (Bergström 1982, Norling 1984), fluviatile (Troedsson 1951) or continental (Norling & Bergström 1987). Unfortenately have not the authors always described on what reasons their additions were made.

The two main Rhaetic coal seams are best developed in the eastern colliery districts on the fringe of the Höganäs trough (Bölau 1964). The lower coal seam is the most uniformly developed one with a maximum thickness of one metre in the colliery districts (Troedsson 1951). Close to the Söderåsen Horst the seams are split up into minor ones. The lower seam is intermediated by lobeshaped sand respectively clay deposits (Troedsson 1951, p. 96). The lithology intermediating the two main seams in the eastern colliery districts displaying a lateral zonation perpendicular to the Söderåsen Horst (Troedsson 1951, p. 99). Close to the Horst the sediments are coarse-grained but decreases in size further out in the Höganäs trough. The main sourse area during Rhaetian times has therefore to be placed in northeast, with a transport direction perpendicular to the Horst (Troedsson 1951).

Location and general remarks

The coal and clay pit at Lunnom is situated between Ekeby and Billesholm (Fig. 2). The pit is one out of two still exploited in NW Scania and the quarrying is carried out by using strip mining technique.

Lunnom is situated at the innermost part of the Höganäs trough, close to the northern limb of the Skromberga syncline (Bölau 1969a). This syncline is a rather shallow depression opened towards the northwest with the largest amount of sediments deposited in its central part along a southeast to northwest trending axis (Bölau 1969a, p. 460).

At the lower part of the pit at Lunnom the coalseam B belonging to the Bjuv Member is exposed. Beneath the coalseam occurs grey kaolinitic clay of economic importance. The clay ought according to the definiton of the Member belong to the Vallåkra Member (Sivhed 1984), but is regarded as a part of the Bjuv Member in core logs from Höganäsbolaget. The uncertain stratigraphical position of this clay unit depends on the presence of kaolinitic clays since this clay mineral is a characteristic feature of the Bjuv Member while the Vallåkra Member contains montmorillonitic clays.

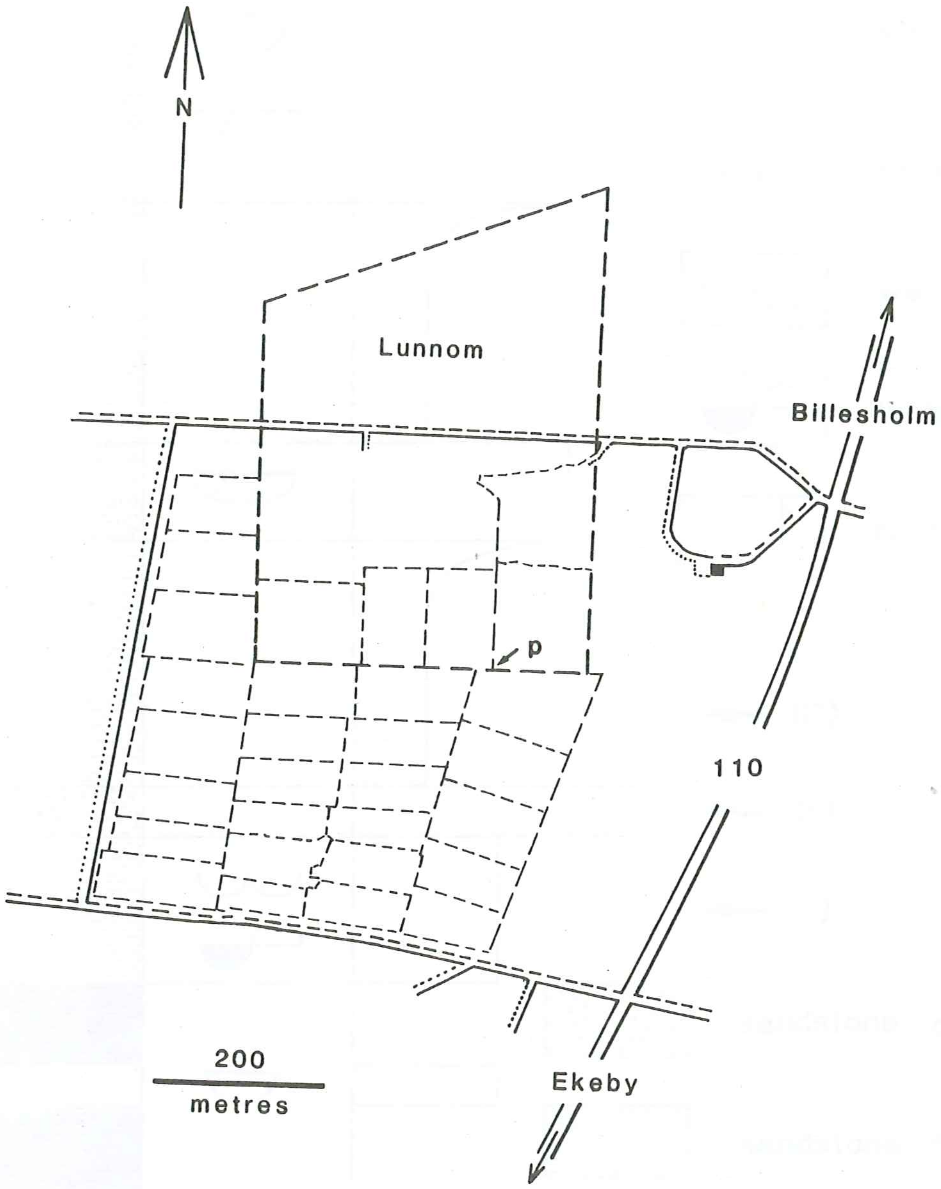

Fig. 2. The coal and clay pit at Lunnom. Map from Gruv kontoret, Bjuv (Mine Office at Bjuv). Letter P marks the investigated profile.

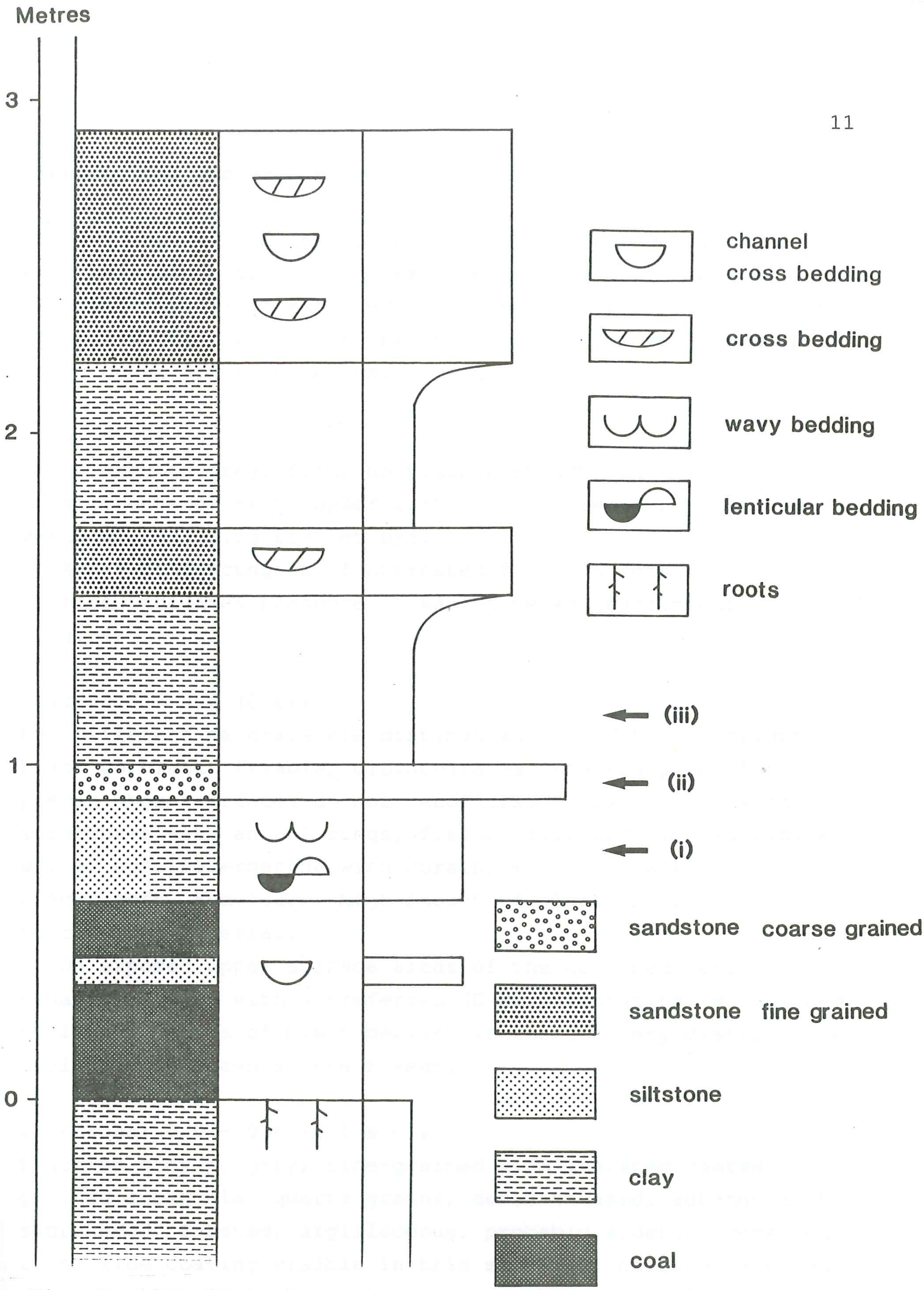

Fig. 3. Lithological section representing strata in the eastern part of the pit. Letters (i), (ii) and (iii) represents sampling levels of palynomorphs.

Lithological succession

The outcrops at Lunnom expose a rather uniform development with only minor facial changes. The measured lithological section (Fig. 3) is situated in the eastern part of the shaft at Lunnom (Fig. 2), since the strata here have well developed structures. Scale in metres.

Clay; -1.0 - 0 (1.0);
light grey to grey, firm, no visible structures, minor constituents of silt, upper 0.10- 0.15 metres penetrated by vertical coalified rootlet bed.

X-ray diffractogram of untreated fraction less than 2 microns indicates presence of kaolinite and hydromicas (Fig. 4)

Coal; 0.0 - 0.6 (0.6);
two different macerals are distinguishable; Vitrein; bright black to black, friable, disintegrates into sharp angular pieces whose surfaces do not recolours, in rare cases wood structures with annual rings, fissure fillings with kaolinite, white, soft,alternating with Durain; mattish black to dull black, soft, recolours, high amount of blackish grey terrigenous material.

On exposed upper surface areas of the coal bed occur remains of logs with a preferred SE-NW orientation, surrounded by large amounts of plant debris. In the colliery district the coal seam is known as the B seam.

Siltstone; 0.0 - 0.6 (0.1 sic);
blackish grey to grey, fine-grained with isolated coarse-grained subangular quartz grains, dense to hard, subangular to subrounded, frosted, argillaceous, probably siderite cemented; iron oxide coating visible in thin sections, calcite detected by boiling in 37 % HCl, non magnetic after heating, minor water escape structures, minor constituents of coal fragments and pyrite.

The siltstone occurs in coal seam B as channel filling material.

Siltstone; 0.6 - 0.9 (0.3);
medium to light grey, finegrained, hard to medium hard, subrounded to rounded, vitreous, quartz cemented, fairly well sorted, poor visible porosity, alternating with *Claystone;* dark grey to greyish black, friable, somewhat silty, no visible porosity.

The alternating siltstone/claystone forms a heterolithic sequence above the coal seam. These heteroliths are well developed in the east, where they are characterized as wavy to connected lenticular bedded with thick lenses, while single lenticular bedding with flat lenses occurs in the west, using the nomenclature by Reineck & Wunderlich (1968). Occurrence of climbing ripples is connected with the presence of distinctly asymmetrical ripples.

Sandstone; 0.9 - 1.0 (0.1);
medium grey to light grey, very coarse to fine grained, hard to medium hard occasionally firm due to the cementation, sharp angular to subangular, coated to vitreous, complex cementation; partly quartz cemented, partly clay minerals, partly crystalline calcite, structureless, poorly sorted, minor constituents of pyrite, plant debris, hematite.

The sandstone unit is easily recognized in this otherwise fine-grained clastic sequence. In the eastern part it occurs mainly as a covering sheet on top of the hetherolithic sequence, while it occurs as isolated bodies in the hetheroliths at the western parts. Since the sandstone is built up with the unusual combination of coarse and sharp angular quartz grains in this otherwise fine-grained clastic sequence, it is treated more in detail below.

Claystone; 1.0 - 1.5 (0.5);
dark grey, firm to medium hard, no visible structures, silty, increased amount of silt in the upper 0.10-0.15 metres.

XRD analysis on the fraction less than 2 microns shows a graph almost identical with that of the clay below the coal seam (Fig. 5). In the colliery district this unit is known as the chamotte clay.

Sandstone; 1.5 - 1.7 (0.2); light grey to yellowish grey, fine grained, hard to medium hard, subrounded, vitreous, quartz cemented occasionally with a thin iron oxide rim, small-scale cross stratification, fairly well sorted, minor constituents of dark organic clay on bedding planes, crystalline calcite as pore filling material, fair visible porosity.

The sandstone is sometimes described as clay ironstone in core logs.

Claystone; 1.7 - 2.2 (0.5);
dark grey, firm, no visible structures, plant debris, increased amount of silty fraction in the upper 0.10 - 0.15 metres.

Sandstone; 2.2 - 2.9 (0.7);
light grey to yellowish grey, fine grained, hard to medium hard, subrounded, vitreous, quartz cemented, occasionally with iron rime, small scale cross stratification increasing upwards in scale, fairly well sorted, minor constituents of dark organic debris covering surfaces along bedding planes, crystalline calcite as pore filling material, poor visible porosity.

In the upper sandstone unit strikes lens shaped large channels heading in a southeast - northwest direction.

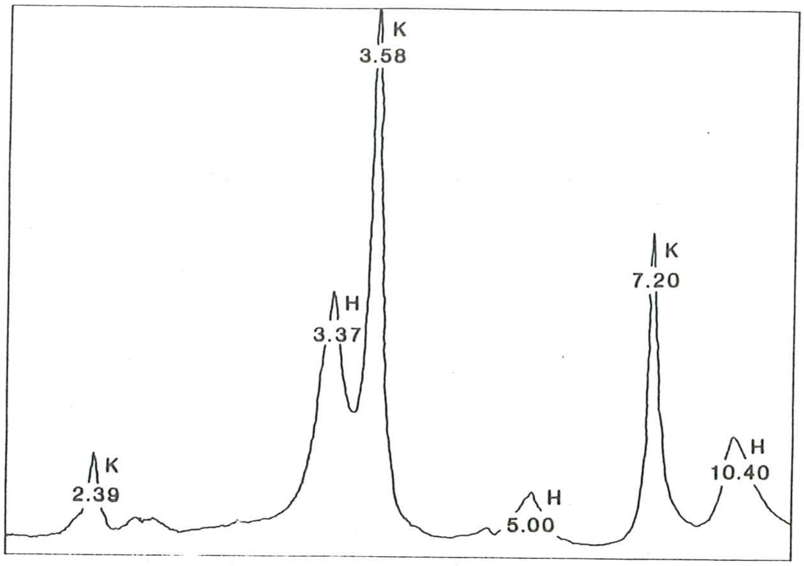

Fig. 4. X-ray diffractogram of the lower clay unit. The graph indicates kaolinite (K) and hydromicas (H). Measured values in Ångström.

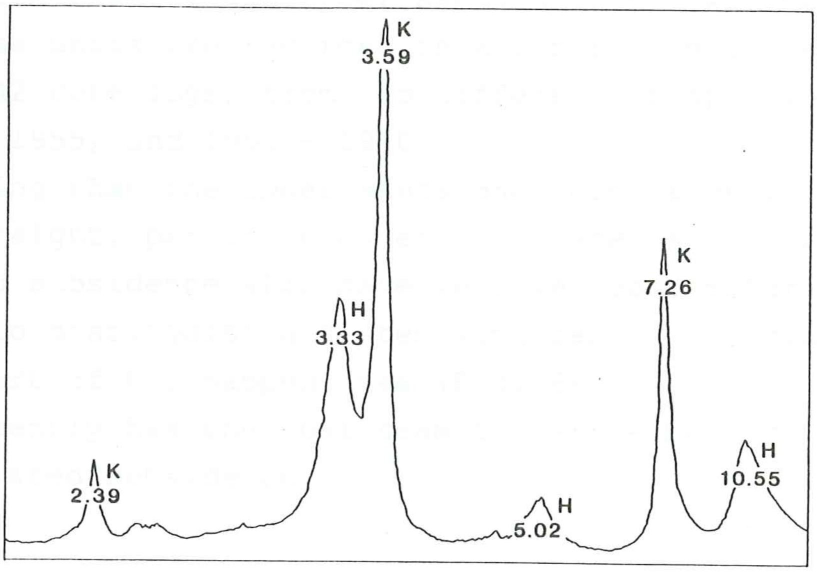

Fig. 5. XRD of the upper clay unit. The graph indicates kaolinite (K) and hydromicas (H). Measured values in Ångström.

Methods and results

Lateral differentiations

An isopach map covering the Lunnom area was constructed to detect divergences in thickness of the distribution of the strata. For that purpose units between the top of the coal seam and the base of the upper sandstone unit was measured since these units are recorded in all core logs. The map is based on 42 core logs, from two different prospecting periods in 1954 - 1955, and 1968 - 1970.

Presuming that the upper sandstone unit is deposited with a rather straight, perhaps even erosive base, and areas with the most rapid subsidence also have received most material, it is possible to distinguish a system with basins and ridges in the central part of the mapped area (Fig. 6).

Consequently has the coal-seam therefore been subject to differentiated subsidence.

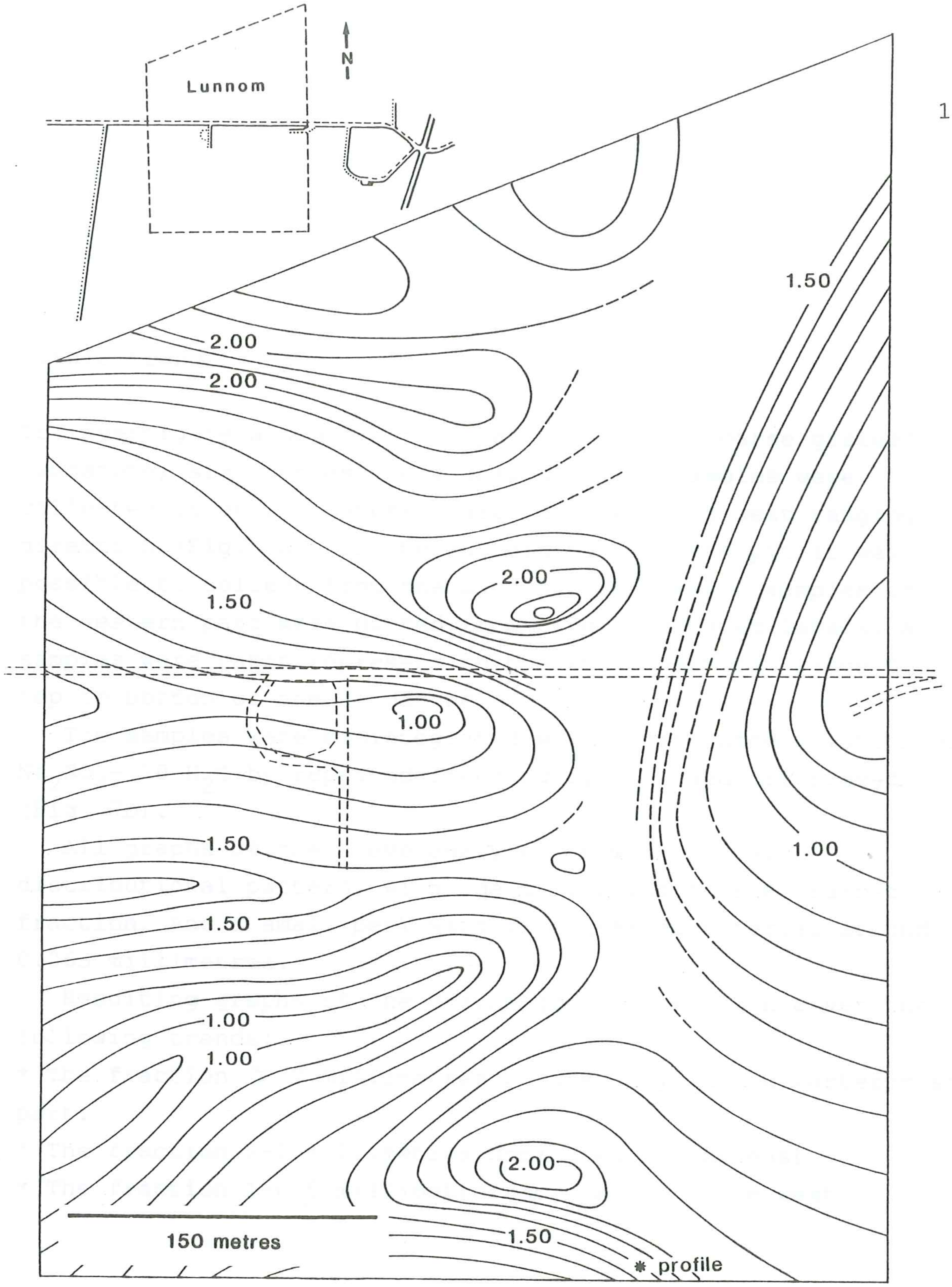

Fig. 6. Isopach map of the Lunnom area viewing the distribution of strata between coal seam B and the upper sandstone unit. Isopachs with 0.10 metres equidistance. Bold lines are used for certain graphs and dashed lines for more uncertain ones.

Lithic trend

To investigate a depositional pattern of the coarse-grained sandstone, six samples where analysed. The samples were collected about 100 meters apart in an east to west ranging direction (Fig. 7a). In the eastern part of the pit it was possible to collect from the same horizon, while samples in the western part were picked from single isolated lenses. All samples were taken representing the whole vertical range from top to bottom of the sandstone.

The samples were disintegrated with a saturated solution of Na_2SO_4- 10 H_2O by repeated freezing cycles, and dry sieved (Fig. 7b).

All graphs of the sieve analyses show a bimodal distributional pattern, with one dominating coarse-grained fraction, and a small peak with fine-grained material around 0.063 millimetres.

Resulting graphs of the coarse-grained fraction gives the following trends;

* The fraction $>$ 2 millimetres occurs only in the easternmost part.
* The fraction 2-1 millimetres dominates in the east
* The fraction 1-0.5 millimetres dominates in the west

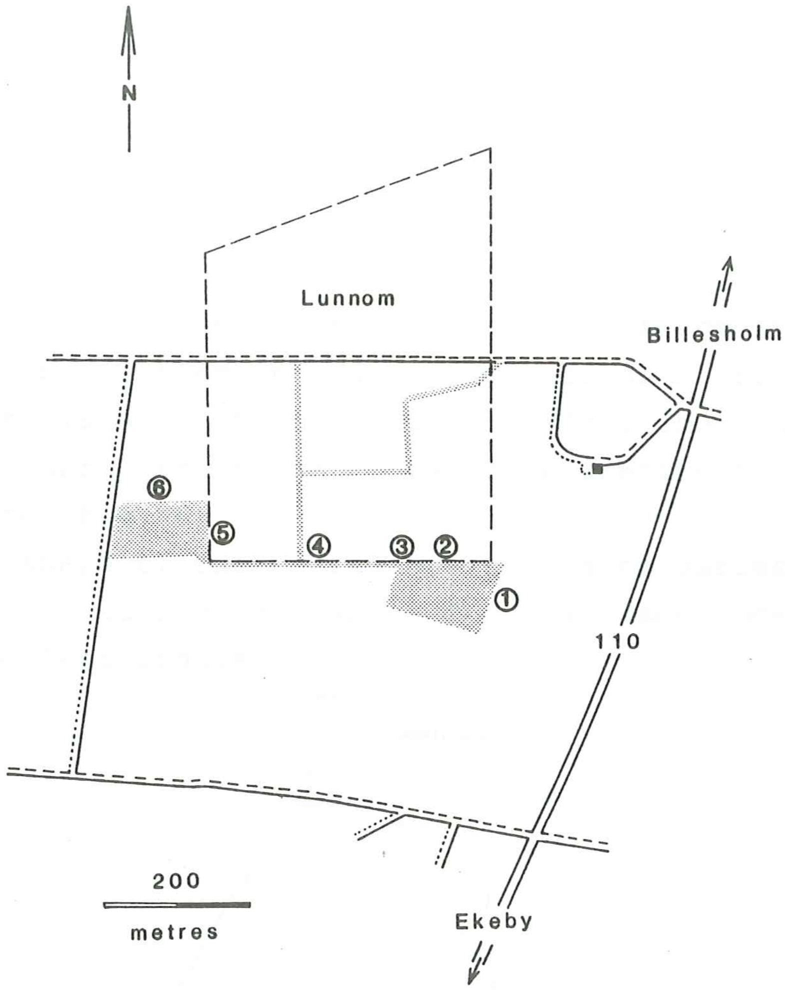

Fig. 7a. Sampling sites of the coarse-grained sandstone at Lunnom.

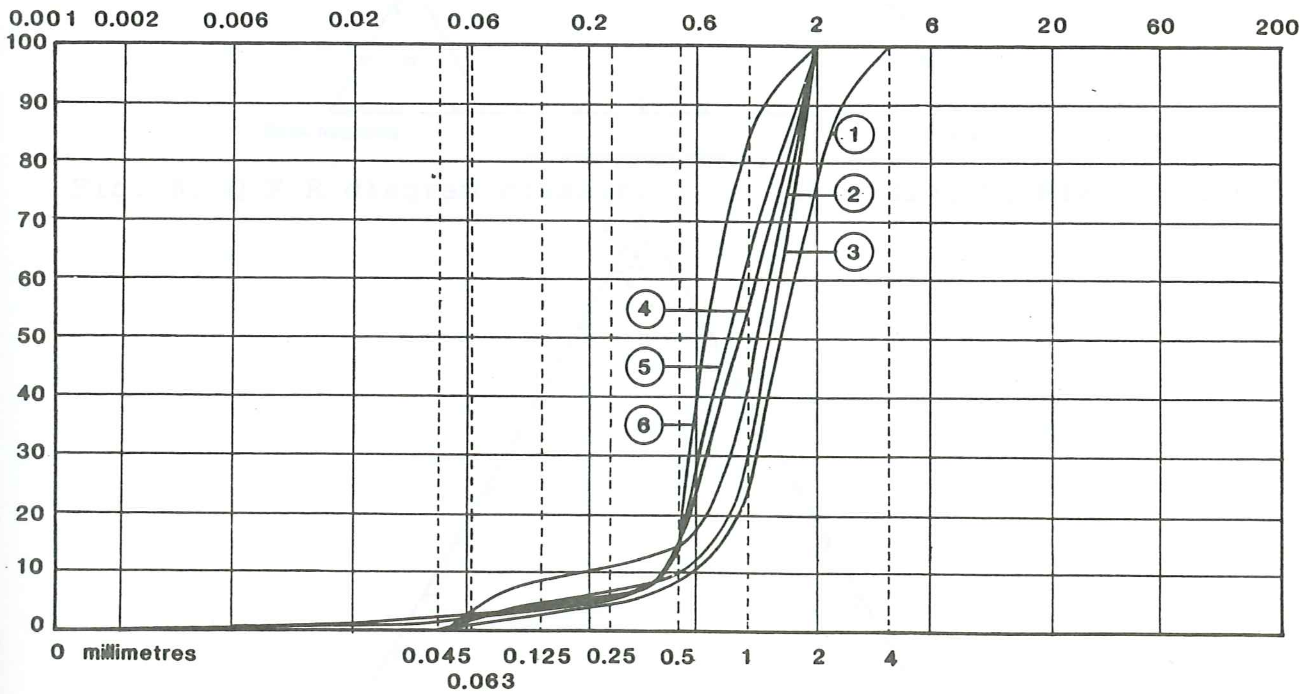

Fig. 7b. Graphs of sieve analyses.

Lithic components

Clasts of quartz (Q), feldspars (F) and rock fragments (R) were counted and plotted into a triangle diagram (Fig. 9). Following the classification by Miall (1979), the examined sandstone is characterized as a quartzoze arenite to a pure quartz arenite (Fig. 8).

The grain shape of the coarse quartz clasts varies between sharp angular to subangular, while feldspars and rock fragments are less angular.

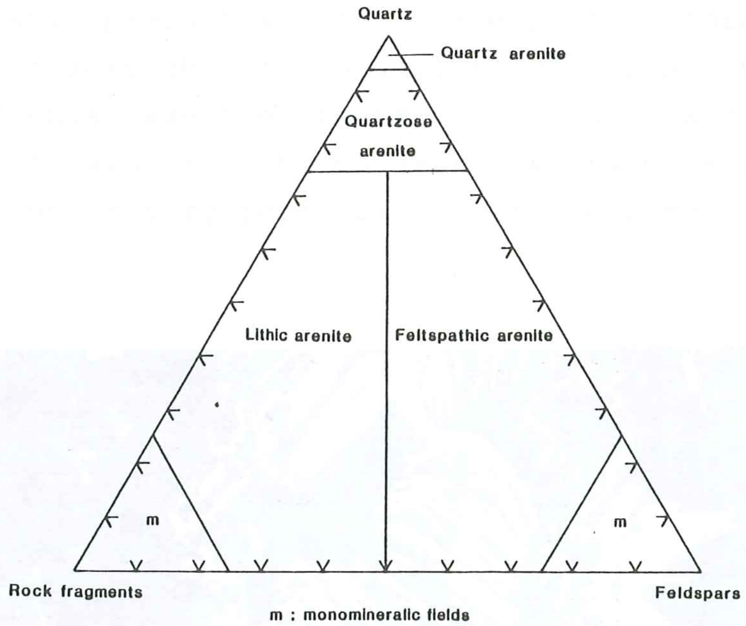

Fig. 8. Q F R diagram classification according to Miall (1979)

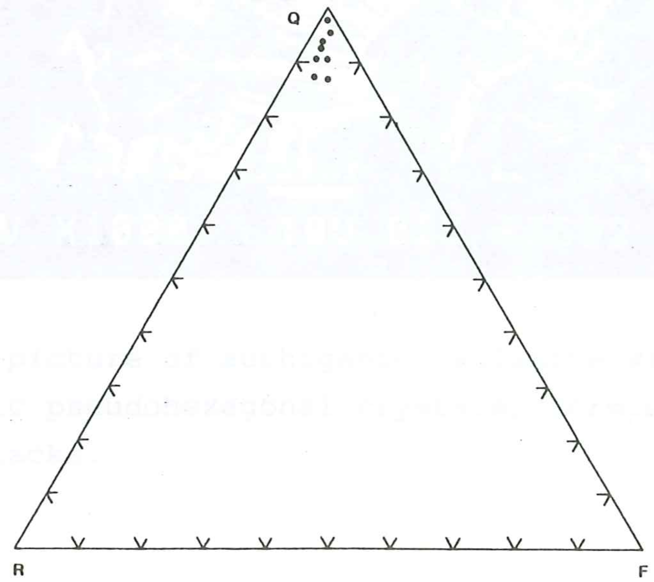

Fig. 9. Q F R diagram of the sandstone.

Cement constituents

Samples for scanning electron microscopy investigations were treated after a method described by McHardy & Birnie (1987), using Au-Pd alloy for coating. The only observed clay mineral as a diagenetic element was authigenic kaolinite (Fig. 11). This mineral is easily detectable because of its very characteristic pseudohexagonal plates, often forming curved vermicular stacks (Hancock & Taylor 1978, Scholle 1979, p. 70). In this case the crystals are coarse and skeletal, typical in fluvial sandstones (Hurst & Irwin 1982) and indicate high primary permeability of the sandstone (Hawkins 1982).

Fig. 11. SEM picture of authigenic kaolinite with characteristic pseudohexagonal crystals, forming curved vermicular stacks.

Diagenetical phases

Three diagenetical phases of the coarse-grained sandstone may be recognized. The first phase is an feldspar replacement by authigenic kaolinite. Feldspar decomposition has long time been associated with circulation of slightly acid pore fluids (Schmidt 1985). The process follows the idealized formula;

$$2\ KAlSi_3O_8 + 2\ H^+ + H_2O \longrightarrow Al_2Si_2O_5(OH)_4{}^+ + 4\ SiO_2 + 2\ K^+$$

(Blatt *et al.* 1972)

In a second phase SiO_2 is released and will under favorable conditions form new almost perfect crystalls (Hurst & Irwin 1982). In this case only small amounts of recrystallized silica is observed

A third and last phase comprises a process where authigenic kaolinite crystals are trapped in the sediment by pore space fillings of crystalline calcite. This carbonate phase post-dating a phase of authigenic clay is a common observed process (Hurst & Irwin 1982).

Palynomorph content

Parts of the Rhaetian palynomorphs material from Scania, investigated by Lund, his samples 2, 3 and 4, originate from Lunnom (Lund 1977, p. 36). Even if the sampled horizons are well described there seems to be a too large vertical distance between the sampled units, or simply that the heterolithic sequence and the sandstone were not exposed at that time. All the Rhaetian samples from Lunnom, investigated by Lund (1977), contains the diagnostic miospores *Rhaetipollis germanicus* (Schultz), and *Limbosporites lundbladi* (Nilsson), which refers the strata at Lunnom to the mid-Rhaetic.

To get a closer look at the results presented in Lunds paper (1977), concerning the Scanian samples originating from Lunnom, three samples were selected, all deriving from beds between Lunds zone 3 and 4, and representing (i) heterolithic silt/claystone, (ii) coarse-grained sandstone and (iii) dark clay (see Fig. 3). The samples were treated by a slightly modified method described by Vidal (1976).

Only selected diagnostic miospores and important accessory palynomorphs of the *Rhaetipollis-Limbosporites* miospore Zone, according to Lund (1977), and specimens of *Botryococcus* were counted (Table 2).

All three lithologies contains the important zonalfossil *Limbosporites lundbladi* (Nilsson), indicating assignment to the mid-Rhaetian strata (Lund, 1977).

In addition to the distribution of diagnostic palynomorphs of the zone, it is possible to detect a preservational pattern of the organic material. Samples representing the heteroliths and the sandstone are rich in well preserved, thick-walled, dark brown palynomorphs, mainly tetrahedral forms of *Riccisporites tuberculatus* (Lundblad).These are very common in Rhaetian floras (Lundblad 1959a).

The clay is much poorer in palynomorphs. These are often poorly preserved, sometimes even fragmented, and much lighter in colour. If this can be related to a light refraction phenomena due to thinner walls, or indicates another water energy regime remains to be answered.

Besides the above mentioned flora, the samples contain specimens of *Botryococcus* (Guy-Ohlson, pers. comm.). These belong to freshwater living algae (Remy & Remy 1977), by some authors even restricted to lacustrine areas (Robert 1988). The genus *Botryococcus* is known from both temperate and tropical climates (Taylor 1981).

Table 2. Distribution of diagnostic miospores and important accessory palynomorphs of mid-Rhaetian *Rhaetipollis-Limbosporites* miospore zone according to Lund (1977).

	heteroliths	sandstone	dark clay
C. torosus	5	17	4
C. mesozoicus	-	2	-
L. lundbladi	6	7	3
R. germanicus	1?	-	-
P. polymicroforatus	5	6	-
Semiretisporis	1	5	2
R. tuberculatus	41	53	6
P. minimus	1	7	1
Ovalipollis	3	11	-
Deltoidospora	5	7	-
C. rhaeticus	-	2	-
C. zwolinska	-	2	-
T. rhaeticus	-	3	-
A. parvispinosus	3	2	2
Botryococcus	7	2	-

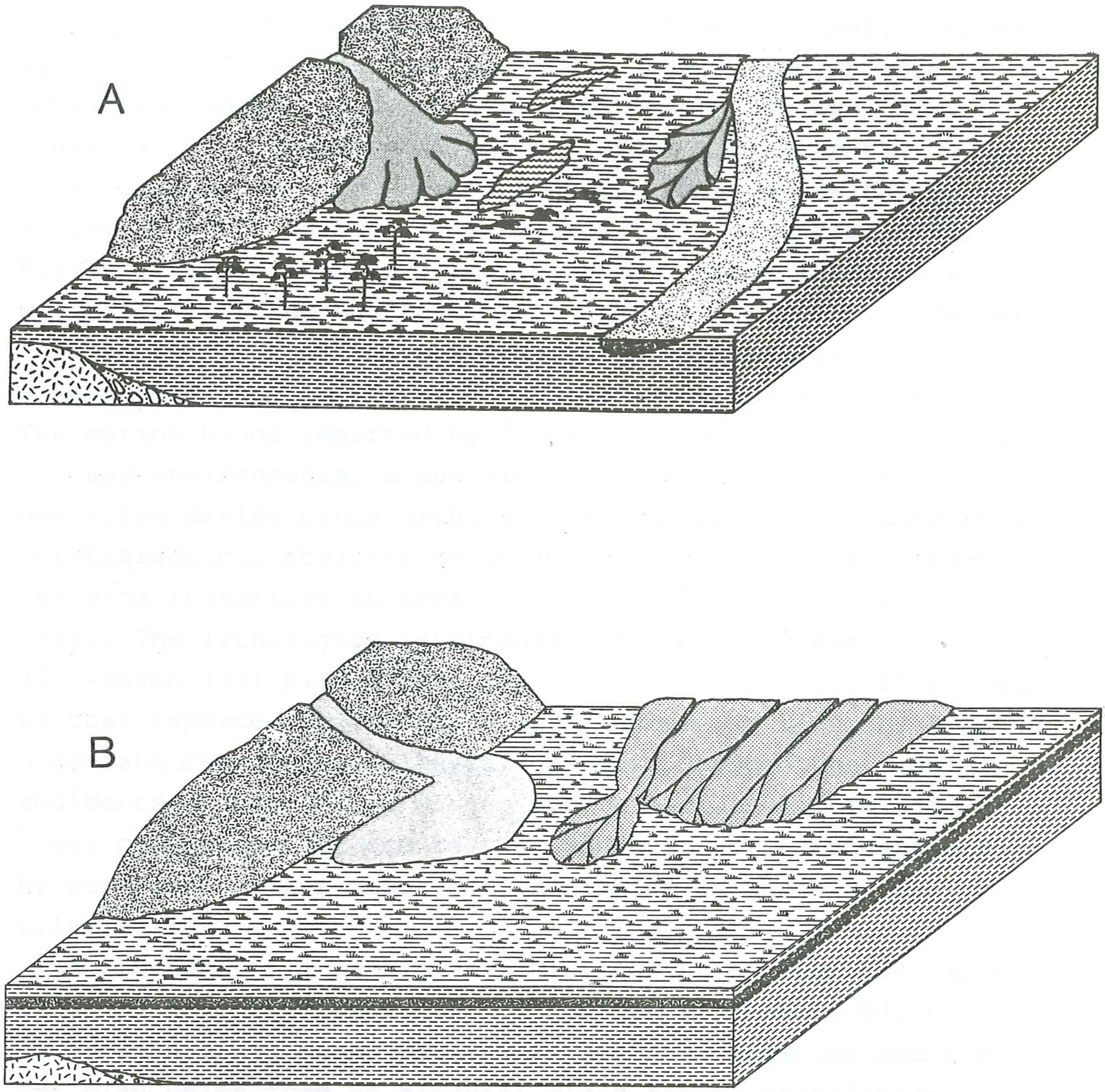

Fig. 12. Depositional model over the Lunnom area in mid-Rhaetian times.Two facies associations may be recognized;
A: Alluvial plain facies association.
B: Braided river facies association.

Depositional model

Presence of coal has long been associated with deltaic environments (McCabe 1984). A delta is however a very complex system which could be devided into a lower-, and an upper deltaplain and an alluvial plain, each with its own characteristic features (Fielding 1985). Adding up the previously descriebed additions to the Rhaetian deltaic environments in NW Scania (Troedsson 1951, Bergström 1982, Norling 1984, Norling & Bergström 1987), these indicate a wide spectra of depositional processes, all present in deltaic environments. Unfortunately have the present authors not always described on what facts their additions were based. The marine bands reported by Troedsson (1951) are not useful for any environmental discussion since two out of his three described marine bands origins from boulders of most uncertain stratigraphical position (Troedsson 1949). One boulder even contains indistinct stonecasts of a dwarf fauna (Troedsson 1949). The lithologies intermediating the main seams (Troedsson 1951 p.99), displays a similar depositional pattern as that reported by Collinson (1982) from the Scoresby Sund on Greenland regarded as alluvial deposits, though the Scanian sediments are deposited during more humid conditions. The lower coal seam is close to the Söderåsen Horst intercalated by sediments with a distribution similar to those of an alluvial fan.

At Lunnom it is possible to distinguish between two facies associations. The lower part of the pit with the coal, the heterolithic sequence, the coarse-grained sandstone and the two clay units form an alluvial plain facies association, while the both cross-bedded sandstone units in the upper part indicate a braided river facies association.

The light grey clay below coal seam B, that constitutes the lowermost exposed part in the Lunnom area, compose a part of the Skromberga syncline (Bölau 1969a, p. 460). The kaolinitic clay unit is settled during a large-scale outwash of weathered crystalline basement.

The small rootlet bed in the topmost part of the clay unit indicates a stabilization of the substrate and establishment of vegetation.

The coal horizon represents an overbank part of the sequence at Lunnom. The coal seam is the remains of a bog with a minor drainage pattern. The coals are partly authocthonous and partly allocthonous with terrigenous influx swashed together in subsidence influenced basins. This interpretation is supported by the occurrence of orientated logs and large amount of plant debris.

The isopach map (Fig. 6) of the intervening beds indicates a depositional system with small ponds and ridges. The best developed heterolithic sequeces are resticted to the areas with the most extensive subsidence. This means that the heterolithic sequence was formed in the deepest part of the basins, though not deeper than the sediments were influenced by fluviatile and wind induced wave action. Looking at the palynomorphs in the heterolithic sequence then especially on the mode of preservation they indicate a rapid burial close to continental areas. Comparing the heterolithic bed at Lunnom, with the beds at Bjuv and Hyllinge it is possible to detect similarities in the lithology. The occurrence of plant debris together with vertebrate remains at Bjuv and Hyllinge indicates fresh water environments close to continental areas. Even though the sediments at Bjuv and Hyllinge are not laterally equivalents to those at Lunnom, they all indicate presence of small waterfilled depressions.

The sandstone unit is deposited by repeated high energy events, since it occur as isolated dunes in the heterolithic sequence in west, and mainly as a covering sheet on top of the heteroliths in east, that makes them impossible to be synchronous. The lithic trend in grain size with a bimodality points to two different source areas. The fine-grained fraction derives from the more common environments represented by the heterolitths, and the coarse-grained from some kind of events.

The palaeotransport direction shows a possible source area in the east, and since it occurs Kågeröd material as well as crystalline basement in this area according to geological maps (Sivhed 1986), it is most likely that the sourse area is situated in the east. The repeated events might be explained with two different models.

The first model is a more common one with repeated events caused by small-scale crevassing of channel bedload material into the small subsiding basins. A weak argument for this theory is that no larger channel as transport media is known from the areas around Lunnom.

The second model is consequently more controversial but is difficult to disregard. In this case the repeated events might be explained as due to vicinity of an alluvial fan. The most distal part of the fan is notched in its edge by a fluviatile agent and the alluvial material is transported into areas with differentiated subsidence. Finally a larger part of the fan slides into the area changing the waterway distribution, in this case represented by the lithological change to the argillaceous unit. This model needs a source area rather close to Lunnom and this is fulfilled by the above mentioned Kågeröd material and weathered crystalline basement in east.Further on this model also gives the best explanations of the coarse-grained sharp angular material as shortly transported, while a channel transport would have given less angular grains.

The clays in the upper clay unit displays the same mineral content and proportions as the lower clay unit. This indicates that the same conditions prevailed when the two clay units were deposited. The visible variations only depends on different coloration due to organic debris in the upper clay unit. The similarities of the both clay units strengthens the theory of an alluvial plain facies association. This also means that the coal seam and the heterolithic sequence reflects a temporary overbank part, in this otherwise argillaceous facies of the alluvial plain.

The increasing amount of silt in the upper part of the clay unit followed by a sharply based sandstone indicates increased water energy capable of carrying a more suspended load, and the approaching of a more arenaceous facies. The small cross-bedded sandstone unit is possibly the remains of a lobeshaped sand bar, moving in front of a larger sandy complex. This is the first indications of an approaching, active braided river system. The thin clay unit between the sandstone units is probably deposited behind the sand lobe in a calm area in front of the sandy complex.

The upper sandstone unit, has like the lower sandstone unit an erosive base indicating increasing water energy. The unit represents a braided river system, with a pro facies of active lobes. The front of the sand complex has a rather low wedge shaped that makes foresets difficult to detect, and indicates movement into an area with a rather low relief. Increasing scale of cross bedding stratification indicates a slowly forward mowing sand complex with a braided riversystem.

As partly observed in the Lunnom area it is most likely that the Rhaetic sediments in NW Scania are deposited in environments more influenced by alluvial processes than formerly described.

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